Math for Laser and Optics Technicians

Algebra

Algebra Equations

Variables and Constants

Photonics technicians need to work with many different algebraic expressions that involve variables and constants, simplifying them, solving for a desired variable, and substituting known values for given quantities.

EXAMPLE

You are measuring the characteristics of an argon-ion laser with a cavity length (distance between mirrors) of 50 cm. The gain medium fills the space between the same two mirrors. The reflectivity if the HR (high-reflectivity mirror) is 0.998. The reflectivity of the output mirror is 0.9575. You determine that the round trip gain (loop gain) is 0.969 for a round trip cavity loss of 8.0%. You want to calculate the amplifier gain GA of the laser with the following equation:

$$G_L = R_1 R_2 G_A^2 (1-\alpha)$$

where G_L Loop gain
R_1 Reflectivity of HR mirror
R_2 Reflectivity of output mirror
G_A Amplifier gain
α Round trip cavity loss

Question

What do you find for the amplifier gain, G_A?

Helpful Reminder

Order of operations

1. **P**arentheses—Evaluate all operations inside parentheses and brackets (grouping symbols).
2. **E**xponents—Evaluate all exponents and powers.
3. **M**ultiplication and **D**ivision—Multiply and divide from left to right.
4. **A**ddition and **S**ubtraction—Add and subtract left to right.

Please **E**xcuse **M**y **D**ear **A**unt **S**ally

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Solution to Algebra Question

$$G_L = R_1 R_2 G_A^{\,2}(1-\alpha)$$

$$\frac{G_L}{R_1 R_2 (1-\alpha)} = G_A^{\,2} \qquad \text{(Divide each side by } R_1 R_2 (1-\alpha).\text{)}$$

$$\sqrt{\frac{G_L}{R_1 R_2 (1-\alpha)}} = G_A$$

G_A = 1.05, a pure number without units

$$G_A = \sqrt{\frac{0.969}{(0.969)(0.9575)(1-.08)}}$$

$$G_A = \sqrt{1.1022}$$

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